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Defense Acquisition University

Foundational Learning

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# Designing for Supportability

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# Overview

- Goals of Defense Acquisition
- Definitions
- Problem Statement
- Policy
- Process Drivers
- Tradecraft
- Analytical Tools
- DAU Curriculum
- Questions & Answers

# What are the Goals of Defense Acquisition?

- Provide A Needed Military Capability
- Meet User Needs
- Be Affordable
- Minimize Risk
- Uphold The Public Trust / Accountability

# Definitions: Supportability

- **Supportability** is the degree to which system design characteristic of reliability and maintainability and planned product support resources meet operational and sustainment requirements.
- **Supportability Analysis** is the process by which reliability and maintainability, operational requirements, existing support systems and integrated product support objectives and outputs an integrated life cycle product support infrastructure/resources for the system.

# Definitions: Operational Effectiveness/Suitability

- **Operational effectiveness** is the overall degree of **mission accomplishment** of a system when **used by representative personnel** in the **environment planned or expected for operational employment** of the system considering organization, training, doctrine, tactics, survivability or operational security, vulnerability, and threat.
- **Suitability** is the degree to which a system can be satisfactorily placed in field use, with consideration given to **reliability**, **availability**, compatibility, transportability, interoperability, wartime usage rates, **maintainability**, safety, human factors, **manpower supportability**, **logistics supportability**, **documentation**, environmental effects, and training requirements.

# Problem Statement: DOT&E 2007 Annual Report

"..50% of systems tested were found to be "Not Suitable."

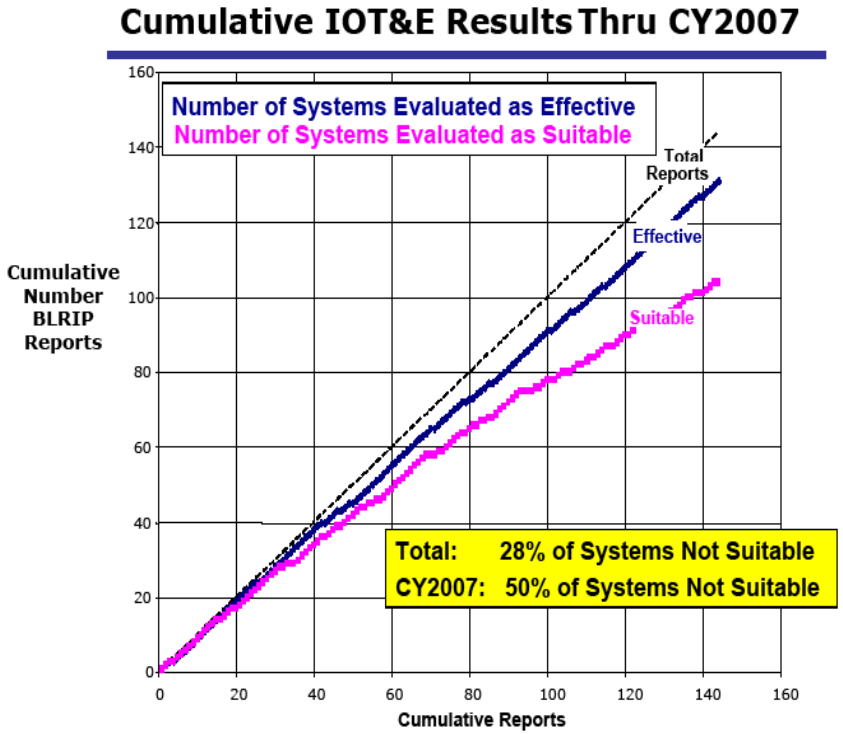
"..80% of the "Not Suitable" systems failed due to reliability.

" ..failed System suitability – especially reliability – directly impacts our warfighter's performance drives system life cycle costs. Put simply, poor reliability means higher sustainment cost."

"..a clear linkage between investment to improve reliability and reduced life cycle costs. Average expected reliability ROI is 15 to 1.'

"..earlier reliability investment (ideally, early in the design process), could yield even larger returns with benefits to both warfighters and taxpayers.

"..steps to improve suitability: the statement of requirements, contract provisions, early discovery of failure modes in developmental and operational test (DT/OT), and the collection of field

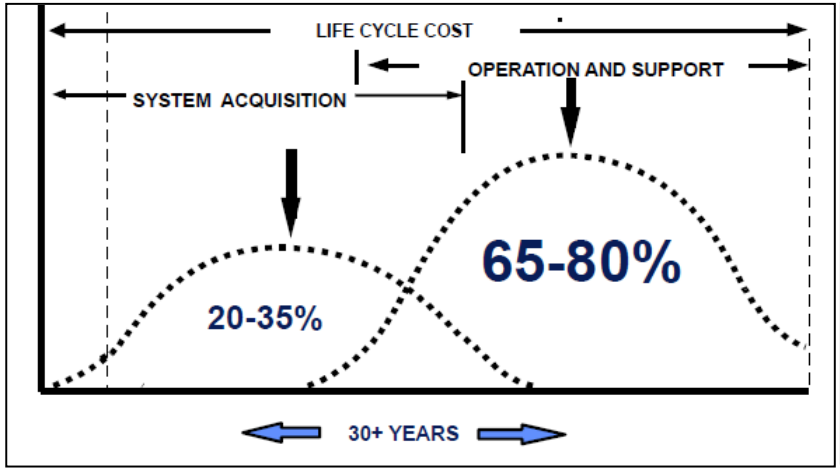


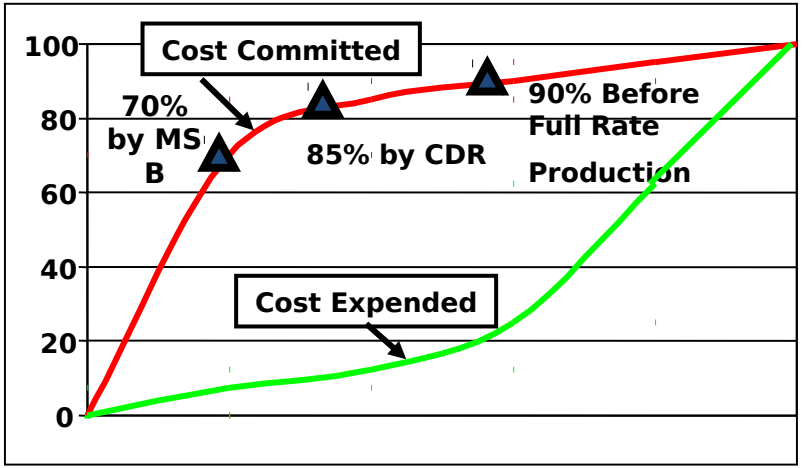

Established the basis of the Weapons System Acquisition Reform Act of 2009.

# Problem Statement

Cycle Cost

- 70% of design-related costs are locked in place by Milestone B
- Service Life continues to increase
- Significant ROI on “early” Reliability/Maintainability

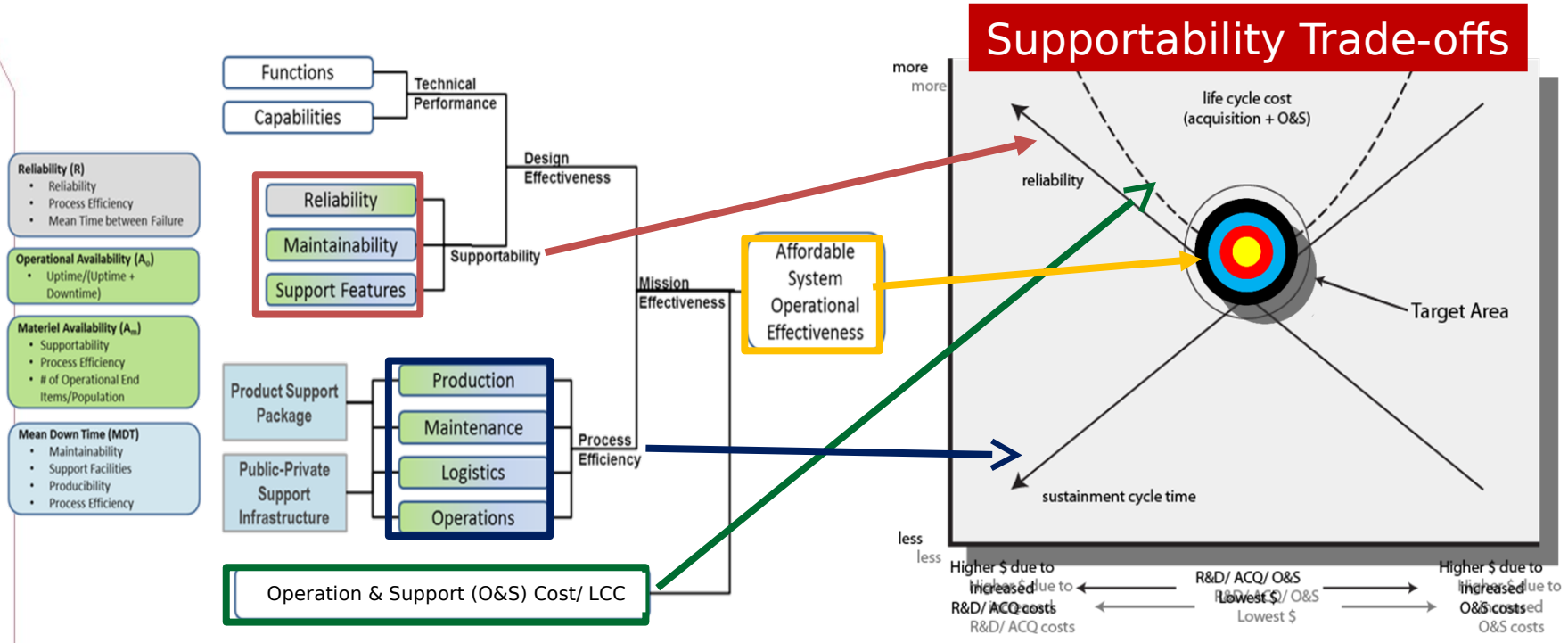



How do Program Management, Engineering, Test & Evaluation and Product Support work collaboratively to address these problems?

# Tradecraft:
# ASOE – Supportability Trade-off

## Affordable System Operational Effectiveness (ASOE) Model




The ASOE Model provides a framework for the integration of technical and management processes based on shared competencies to design, develop, test, field and sustain systems
that are operationally effective and suitable.

# Policy: 5000.01/E.1.1.29 Total Systems Approach

- The PM shall be the single point of accountability for accomplishing program objectives for total life-cycle systems management, including **sustainment**.
- The PM shall apply human systems integration to optimize total system performance (hardware, software, and human), operational effectiveness, and **suitability**, survivability, safety, and affordability.
- PMs shall consider **supportability**, life cycle costs, performance, and schedule comparable in making program decisions. Planning for Operation and Support and the estimation of total ownership costs shall begin as early as possible. **Supportability, a key component of performance, shall be considered throughout the system life cycle**.

# Policy:
# 5000.02 Life Cycle Considerations

"The Program Manager will integrate the product support design into the overall design process, and assess enablers that improve **supportability**, such as diagnostics and prognostics, for inclusion in the system performance specification. As the design matures, the Program Manager will ensure that life-cycle affordability is a factor in engineering and sustainment trades."

# Policy:
# JICDS Definition - Supportability

- The ability of the system to identify and/or predict failures down to a certain subsystem level within a given percentage of accuracy. Potential attributes include health management, prognostics and diagnostics capabilities, Condition-Based Maintenance + enablers, support equipment, and parts commonality. Subordinate attributes which may be considered as KSAs or APAs:
- (a) **Built-In Test (BIT) Fault Detection** – A measure of recorded BIT indications which lead to confirmed hardware failures.
- (b) **BIT Fault Isolation** – A measure of recorded BIT indications which correctly identify the faulty replaceable unit, either directly or through prescribed maintenance procedures.
- (c) **BIT False Alarms** – A measure of recorded BIT indications showing a failure when none has occurred.

# Policy: Better Buying Power (BBP)

**Achieve Affordable Programs**
- Mandate affordability as a requirement
- Institute a system of investment planning to derive affordability
- Enforce affordability caps

**Control Costs Throughout the Product Lifecycle**
- Implement "should cost" based management
- Eliminate redundancy within Warfighter portfolios
- Institute a system to measure the cost performance of programs and institutions and to assess the effectiveness of acquisition policies
- Build stronger partnerships with the requirements community to control costs
- Increase the incorporation of defense exportability features in initial designs

**Incentivize Productivity & Innovation in Industry and Government**
- Align profitability more tightly with Department goals
- Employ appropriate contract types
- Increase use of Fixed Price Incentive contracts in Low Rate Initial Production
- Better define value in "best value" competitions
- When Lowest Price Technically Acceptable is used, define Technically Acceptable to ensure needed quality
- Institute a superior supplier incentive program
- Increase effective use of Performance-Based Logistics
- Reduce backlog of DCAA Audits without compromising effectiveness
- Expand programs to leverage industry's IR&D

**Eliminate Unproductive Processes and Bureaucracy**
- Reduce frequency of higher headquarters level reviews
- Re-emphasize Acquisition Executive, PEO and PM responsibility, authority, and accountability
- Reduce cycle times while ensuring sound investment decisions

**Promote Effective Competition**
- Emphasize competition strategies and create and maintain competitive environments
- Enforce open system architectures and effectively manage technical data rights
- Increase small business roles and opportunities
- Use the Technology Development phase for true risk reduction

**Improve Tradecraft in Acquisition of Services**
- Assign senior managers for acquisition of services
- Measure productivity using the uniform services market segmentation
- Improve requirements definition/prevent requirements creep
- Increase small business participation, including through more effective use of market research
- Strengthen contract management outside the normal acquisition chain – installations, etc.
- Expand use of requirements review boards and tripwires

**Improve the Professionalism of the Total Acquisition Workforce**
- Establish higher standards for key leadership positions
- Establish increased professional qualification requirements for all acquisition specialties
- Increase the recognition and support of excellence in acquisition management
- Continue to increase the cost consciousness of the acquisition workforce – change the culture

# Tradecraft: ENG – Product Support Interfaces

| Competencies | Processes | Metrics | Data | Tools |
|---|---|---|---|---|
| • Design Interface<br>• Reliability, Maintainability, Availability<br>• Configuration Management<br>• IUID<br>• RCM / CBM+<br>• Sustaining Engineering<br>• DMSMS<br>• Technical Data Management<br>• PHST<br>• Transportability<br>• T&E | • Integrated Product and Process Development (IPPD)<br>• Affordable System Operational effectiveness Model (ASOE)<br>• Supportability Analysis<br>• Product Support Analysis (PSA) | • Affordability<br>• Sustainment KPP/KSAs<br>• Operational Effectiveness<br>• Operational Suitability | • Requirements<br>• Operational<br>• Product<br>• Test<br>• Field<br>• Financial | • R&M Allocation & Prediction<br>• Reliability Growth Modeling<br>• FMEA/FMECA<br>• PowerLOG-J Product Support Analysis<br>• COMPASS Level of Repair Analysis<br>• CASA Life Cycle Cost<br>• Post Fielding Support Analysis (PFSA) |

# Process Drivers: Sustainment Metrics

- Sustainment Metrics measure criteria as they relate to
  - System design characteristics
  - Efficiency and effectiveness of logistics support
  - User requirements

Mean Down Time (MDT)

# Process Drivers: Supportability Objectives

- Supportability Objectives and the Sustainment Metrics that quantify their achievement describe the support environment in which the system will operate.
  - System maintenance concept
  - Product Support infrastructure
  - Durations of support
  - Reliability & Maintainability characteristics/rates

# Process Driver: Supportability Objectives / Supportability Analysis Linkage

1. Product Support Strategy
2. Product Support Analysis Planning
3. Program and Design Review
4. Application Assessment
5. Support System Standardization
6. Comparative Analysis
7. Technology Opportunities
8. Supportability Design Factors
9. Functional Analysis
10. Support System Alternatives
11. Evaluation of Alternatives and Trade-off Analysis
12. Task Analysis
13. Early Distribution Analysis
14. DMSMS
15. Field Feedback
16. Disposal Analysis
17. Operational Suitability

# Process Drivers: Maintenance Concept

- A statement of general guidelines used to set the parameters for conducting the various support analyses and developing the maintenance plan (identified in the CDD)
  - ❑ Levels of repair (physical/functional)
  - ❑ Repair policies such as “repair v. discard” criteria
  - ❑ Organizational responsibilities
  - ❑ Anticipated availability of resources
  - ❑ Use of contractors
  - ❑ Statutory and Regulatory requirements

# Process Drivers: ENG IPPD Processes

- Technical Management Processes
- Top-Down Design Processes
- Bottom-up Product Realization

# Process Drivers: ENG IPPD Processes

**Technical Management Processes**

- Technical Planning
- Requirements Management
- Interface Management
- Risk Management
- Configuration Management
- Technical Data Management
- Technical Assessment
- Decision Analysis

# Process Drivers: ENG IPPD Processes

**Top-Down Design Processes**

Stakeholder Requirements Definition

Requirements Analysis

Architecture Design

**Bottom-up Product Realiza**

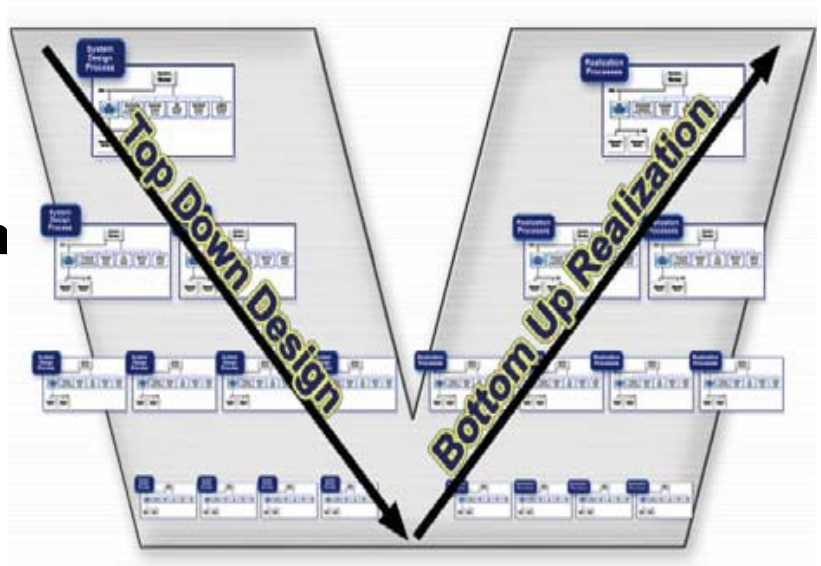
Technical Implementation

Integration

Verification

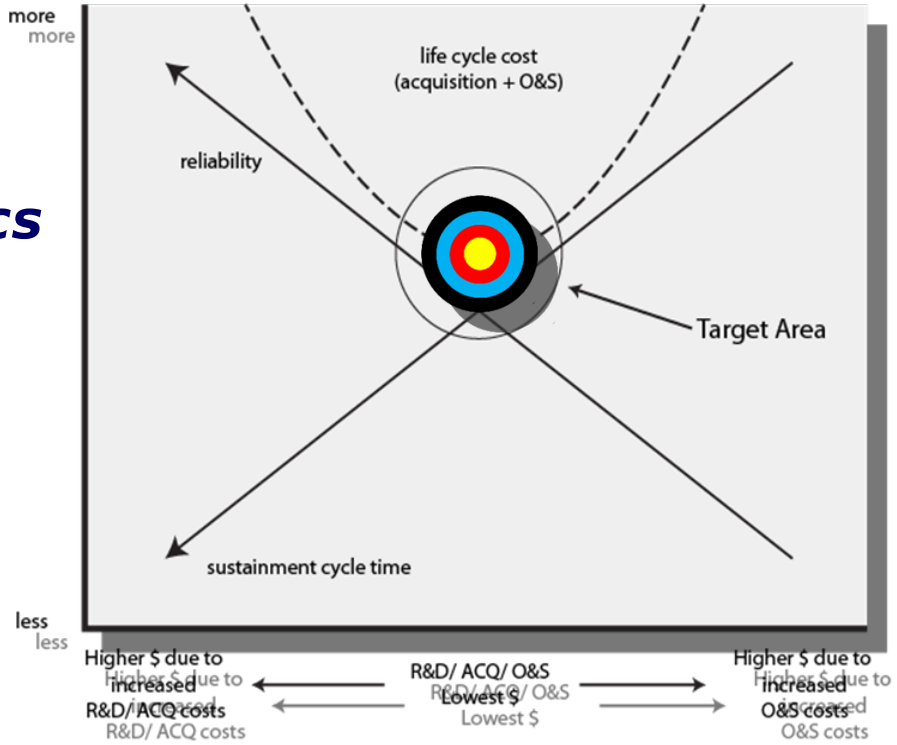
Validation

Transition



# Tradecraft: Design Interface Definition

***The analysis of the impact of the design characteristics of Reliability and Maintainability on performance, product support, and affordability.***



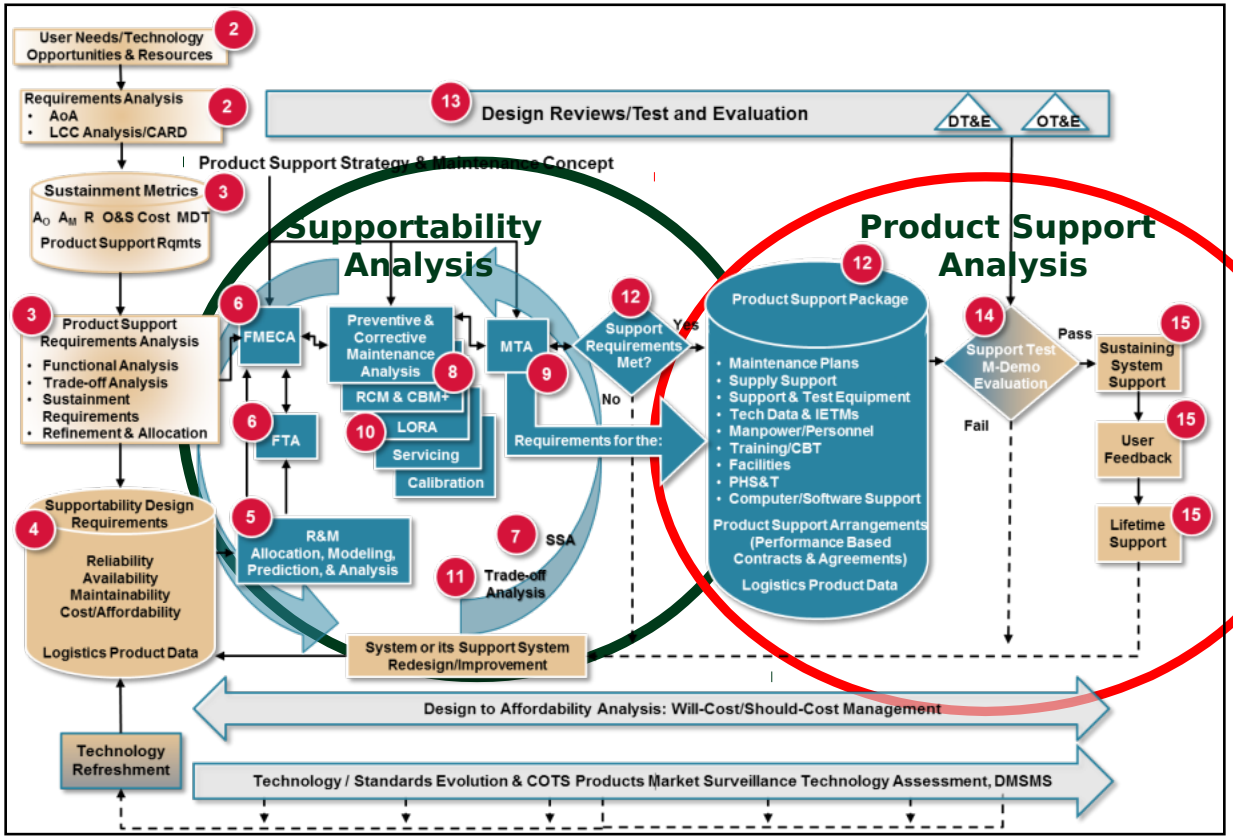
# Tradecraft: Design Interface Activities/Considerations

***The analysis of the impact of the design characteristics of Reliability and Maintainability on performance, product support, and affordability.***

| Program Activities | Design Considerations |
|---|---|
| ▪ Availability<br>▪ Reliability & Maintainability<br>▪ Testability<br>▪ Prognostics & Diagnostics<br>▪ Standardization<br>▪ Interoperability/ Interchangeability<br>▪ Environmental, Safety & Health<br>▪ Human Factors Obsolescence/DMSMS<br>▪ Supportability<br>▪ Software<br>▪ Cost /Affordability | ▪ Analysis of Alternatives (AoA)<br>▪ Trade Studies<br>  ▪ *Requirements*<br>  ▪ *Evaluation Criteria*<br>▪ Functional Analysis<br>▪ Design Analysis<br>▪ Parts & Material Selection<br>▪ Design Limit Life Testing<br>▪ Design for Testing/BIT<br>▪ Manufacturing Plan Screening<br>▪ System Reviews<br>▪ Test & Evaluation |

# Tradecraft: Supportability/Product Support Analysis

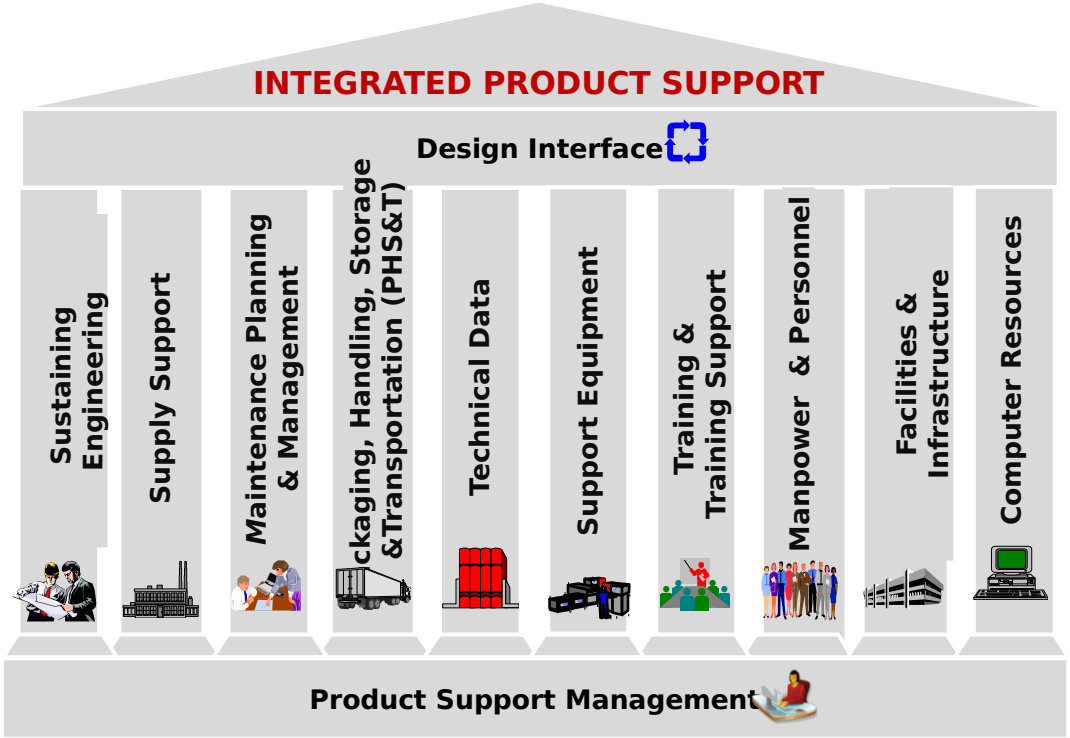
## LOG 211 Supportability Analysis




**MIL-HDBK-502A**

**Product Support Analysis**

# Integrated Product Support (IPS) Elements




Source: Defense Acquisition University

# Tradecraft: Supportability Tasks

| Task | Outputs |
|---|---|
| RAM Allocation, Prediction, Modeling & Analysis | • Requirements Flow-down<br>• Estimated MTBF, MTTR<br>• Reliability Modeling<br>• Redundancy Requirements |
| Failure Modes, Effects and Criticality Analysis | • Single Points Of Failure<br>• Accessibility/Modularity/Testability<br>• Criticality |
| Fault Tree Analysis | • Root Cause Analysis |
| Maintenance Task Analysis | • Preventive And Corrective Tasks, Skills, Tools, Test Equipment, Facilities |
| Reliability Centered Maintenance / Condition Based Maintenance | • Preventive Maint tasks, Cost and Schedule<br>• Prognostics and Health Mgt |
| Level of Repair Analysis | • Maintenance Concept<br>• Repair v Discard<br>• Operational Availability<br>• Maintenance Cost |

# Tradecraft: Product Support Data

| Table | Description |
|---|---|
| X | Indenture Level / Product Structure |
| B | Reliability - RAM/FMECA/RCM |
| BA | RAM Characteristics |
| BD | RAM Indicator Characteristics |
| BE | War/Peace RAM Indicator Characteristics |
| BF | Failure Mode and RCM Analysis Data |
| BH | Failure Mode Task |
| BI | Failure Mode Indicator Mission Phase Code |
| BK | RAM Criticality |
| BL | Mission Phase Operational Mode |

ENG Inputs

| Table | Description |
|---|---|
| X | Indenture Level / Product Structure |
| C | O&M Tasks |
| CA | Task Requirement |
| CB | Subtask Requirement |
| CD | Sequential Subtask Description |
| CG | Subtask Personnel Requirement |
| CG | Task Support Equipment |
| CH | Task Manual |
| CI | Task Provisioned Item |
| CJ | Job & Duty Assignments |
| CR | Subtask Support Equipment Data |
| CS | Subtask Provisioned Item Data |
| H | Provisioning |
| HA | Item Identification (Static Parts List) |
| HC | Contractor Tech Information Code (CAGE) |
| HD | Price |
| HG | Part Application (Dynamic to Indenture) |
| HH | Overhaul-Kit Next Higher Assembly PLISN |
| E | Support, Test & Training Equipment |
| U | Units Under Test |
| F | New or Modified Facilities |
| G | New or Modified Skills |

- **Guidance**
  - Mil-HDBK-502A, Product Support Analysis
  - MIL-HDBK-1390, Level of Repair Analysis
  - SAE-Tech America-0017 Product Support Analysis
- **Tools** (US Army LOGSA)
  - PowerLOG-J Product Support Analysis
  - COMPASS Level of Repair Analysis
  - CASA Life Cycle Cost
  - Post Fielding Support Analysis (PFSA)

# Tradecraft: Supportability Analysis Tools

- Systems Planning & Requirements Software
  https://www.logsa.army.mil/lec/syspars/
- Level of Repair Analysis – COMPASS
  https://www.logsa.army.mil/lec/compass/
- Supportability Analysis Record – PowerLog
  https://www.logsa.army.mil/lec/powerlog/
- Sustainment Supportability Analysis – PFSA
  https://www.logsa.army.mil/lec/pfsa/
- Cost Analysis Strategy Assessment – CASA
  https://www.logsa.army.mil/lec/casa/

# Analytical Tools: SYSPARS - System Planning and Requirements Software

- Management Planning/Documentation Tool
  - Acquisition Strategy
  - Business Case Analysis (BCA)
  - DMSMS Management Plan
  - Performance Specification/Statement of Work (SOW)
  - Item Unique Identification (IUID) Implementation Plan
  - Life Cycle Schedule Materiel Fielding Plan (MFP)
  - Supportability Strategy
  - Systems Engineering Plan (SEP)
  - Test and Evaluation Master Plan (TEMP)

# Analytical Tools: PowerLOGJ2

- Acquisition logistics data management tool that satisfies requirements for Product Support Analysis Records (LSAR).
- Generates 38 Product Support summaries to include:
  - Repair Parts and Special Tools Lists (RPSTL),
  - Maintenance Allocation Chart (MAC),
  - Task Analysis,
  - Provisioning Technical Documentation,
  - Bill of Materials,
  - Failure Modes Effects and Criticality Analysis
  - Technical Manual Reports per MIL-STD-40051 formats.
  - All reports have XML, HTML, and PDF outputs.

# Analytical Tools: Cost Analysis Strategy Assessment (CASA)

- Life Cycle Cost (LCC) decision support tool
  - Life Cycle Cost Estimates
  - Support Concept Trade Studies
  - Production Rate/Quantities
  - Warranty Effectiveness
  - Spares Provisioning
  - Reliability Growth
  - Operational Availability
  - Software Development Costs

# Analytical Tools: Compass

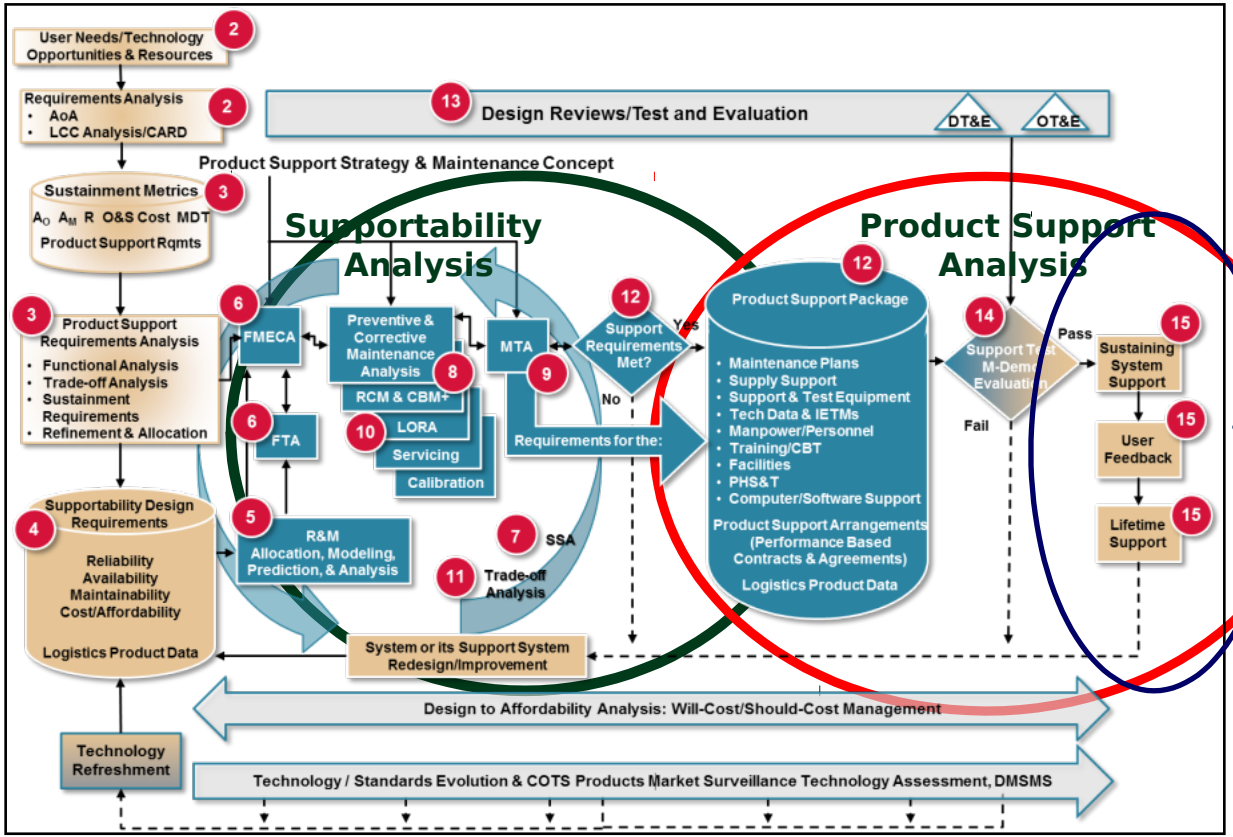
- Level of Repair Analysis (LORA) modeling tool
  - Optimal Maintenance Policy
  - Allocation of resources across the levels of maintenance
  - Cost estimates for initial and replenishment spares, support equipment, manpower, facilities
  - Task distributions
  - Sensitivity Analysis

# Analytical Tools: Post Fielding Supportability Analysis Tools

- PFSA
  - Scientific or technical information necessary to translate system requirements into discrete engineering and logistic support documentation.

# Tradecraft: Supportability/Product Support Analysis

## Post Fielding Analysis




**Sustaining Engineering**

**FRACAS/Post Fielding Analysis**

**Data Collection**

# Sustaining Engineering Analysis

Sustaining Engineering spans those technical tasks (engineering and logistics investigations and analyses) to ensure continued operation and maintenance of a system with managed (i.e., known) risk.

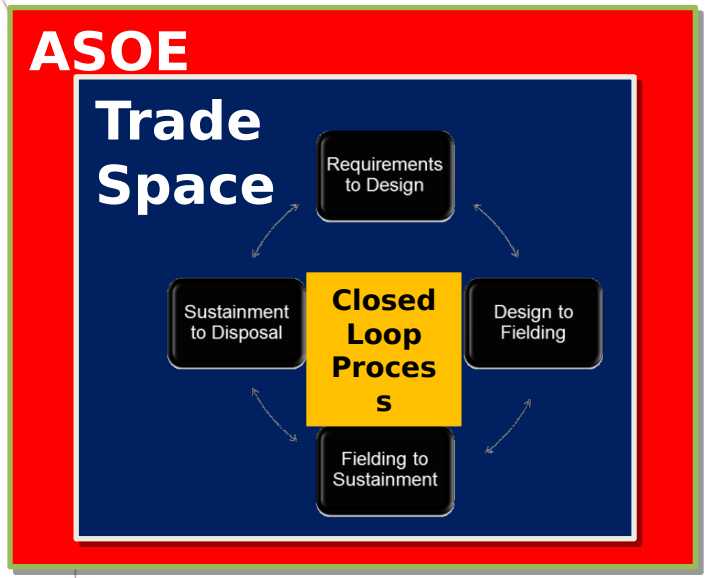
**Sustaining Engineering:**

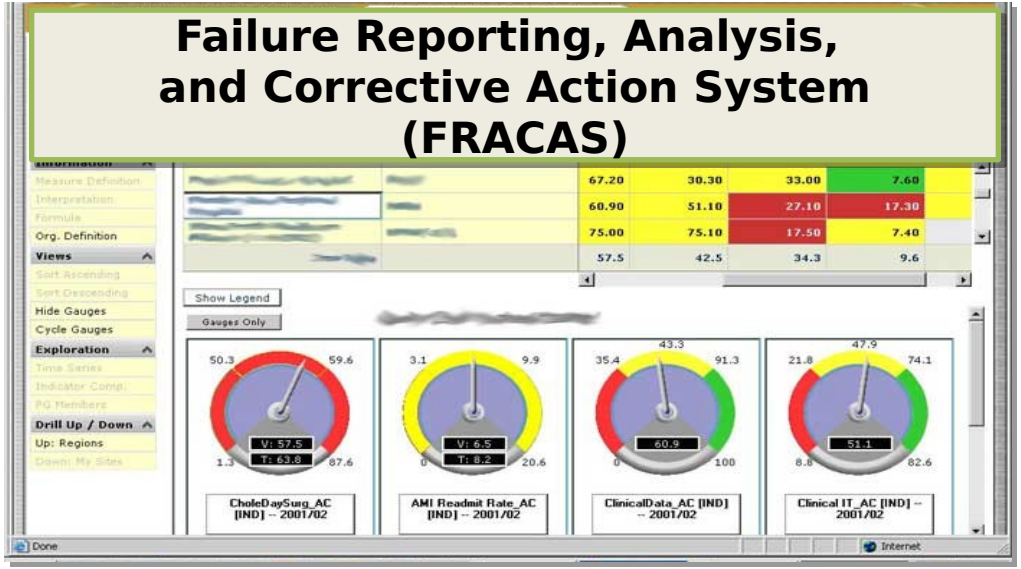
- ❑ Correction of Deficiencies
- ❑ Technology Insertion
- ❑ Incorporation of New Capabilities
- ❑ Improved Product Support

**Are The Levels Of Product Reliability And Product Support Resources Sufficient To Meet System Sustainment Requirements?**

Source: DAU Integrated Product Support (IPS) Element Guidebook

# FRACAS – Post Fielding Analysis




FRACAS serves as the basis for the analysis of safety hazards, failure causes and effects, reliability and maintainability trends, and operational usage profiles changes

sis

Air Force Total Ownership Cost Management Information System (AFTOC)
Army Operating and Support Management Information System (OSMIS)
Navy Visibility and Management of Operating and Support Cost (VAMOSC)
US Army Logistics Support Activity (LOGSA)
Post Fielding Support Analysis (PFSA) Tool
Weapon System Report

A two-year window rolling weapon system performance assessment

- Equipment Availability
- Demand Drivers
- Maintenance Drivers
- Fleet Usage

Source: US Army LOGSA PFSA Tool

# Governance: Sustainment Quad Chart

## Product Support Strategy / Sustainment Approach

- ❑ Current (initial CLS covering total system)
- ❑ Future (sub-system based PBL contracts)

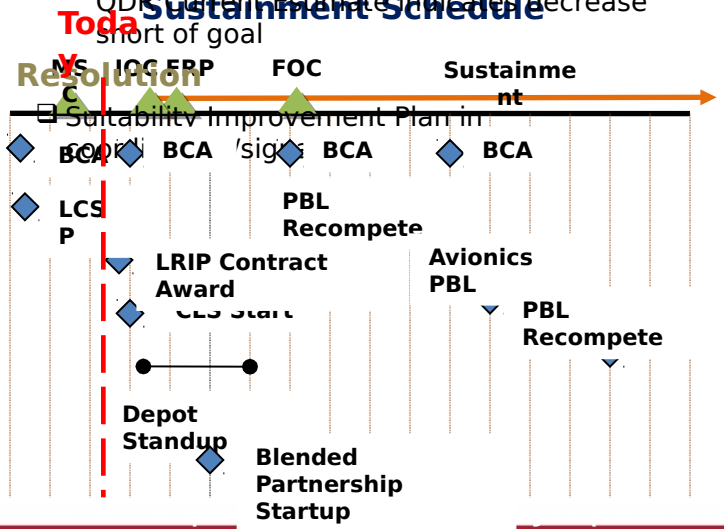
## Issues

- ❑ Suitability Assessment / Quality Deficiency Report (QDR) Status
  - ❖ IOT&E Materiel Availability and Reliability goals not met / QDR Current Estimate indicates improvement short of goals
  - ❖ IOT&E O&S Cost goal met / QDR Current Estimate met goal
  - ❖ IOT&E Mean Down Time metric goals met / QDR Current Estimate indicates decrease short of goal

## Resolution

- ❑ Suitability Improvement Plan in coordi[illegible] 'sign[illegible]

## Sustainment Schedule




## Metrics Data

| Metric | Antecedent Actual | Original Goal | Current Goal | IOT&E Demonstrated Performance | QDR Current Estimate |
|---|---|---|---|---|---|
| Materiel Availability | 76% | 80% | 77% | 69% | 75% |
| Reliability | 37 hrs | 50 hrs | 50.5 hrs | 46hrs | 48 hrs |
| Operating & Support Cost | $7.6B | $9.8B | $10.4 B | 10.4B | $10.4B |
| Mean Down [illegible] | 12 hrs | 20 hrs | 18 hrs | 18hrs | 15 hrs |

## O&S Data

| Cost Element | Antecedent Cost | Original Baseline | Current Cost |
|---|---|---|---|
| 1.0 Unit-Level Manpower | 175.5 | 139.4 | 158.7 |
| 2.0 Unit Operations | 102.1 | 143.0 | 143.0 |
| 3.0 Maintenance | 30.2 | 47.5 | 52.4 |
| 4.0 Sustaining Support | 98.1 | 127.7 | 127.7 |
| 5.0 Continuing System Improvements | 32.6 | 76.3 | 86.0 |
| 6.0 Indirect Support | 38.9 | 80.8 | 79.6 |
| Total | $477.4 | $614.7 | $647.4 |

Cost based on average annual per system in [illegible]

| Total O&S Costs | Antecedent | Street Hawk |
|---|---|---|
| Base Year $M | $7,638.1M | $10,358.3M |
| Then Year $M | $8,936.6M | $12,749.9M |

# DAU Supportability Curriculum/Resources

- **LOG 211 Supportability Analysis**
  - CLL 008 Designing for Supportability in DoD Systems
  - CLL 012 Supportability Analysis
  - CLL 029 Condition Based Maintenance (CBM+)
  - CLL 030 Reliability Centered Maintenance (RCM)
  - CLL 042 Supportability Analysis Techniques, Procedures & Tools
  - CLL 057 Level of Repair Analysis (LORA) -Introduction
  - CLL 058 Level of Repair Analysis (LORA) -Theory & Principles
  - CLL 059 Sustaining Engineering
- **ACQuipedia Articles**
  - Product Support Analysis
    Product Support Analysis (MIL-HDBK-502A) [ACQuipedia]
  - Supportability Design Objectives
    Supportability Design Objectives [ACQuipedia]
  - Design Interface Integrated Product Support (IPS) Element - Design Interface
  - Sustaining Engineering
    Integrated Product Support (IPS) Element - Sustaining Engineering [ACQuipedia]

# DoD and Industry References

- TA-STD-0017, Product Support Analysis (Purchase from SAE)
- GEIA-STD-0007, Logistics Product Data (Purchase from SAE)
- GEIA-HB-0007, Handbook for Logistics Product Data (Purchase from SAE)
- TA-HB-0007-1, Logistics Product Data Reports Handbook (Purchase from SAE)
- MIL-HDBK-502A, Product Support Analysis

# Conclusions and Recommendations

- The Weapons System Acquisition Reform Act (WSARA) of 2009 re-invigorated Program Management, Engineering, Test & Evaluation and Product Support processes to focus on Reliability Growth, and the KPPs of Availability and Affordability.
- Engineering and Product Support share key competencies that enable the integration of their activities to enhance operational effectiveness and suitability
- Analytical tools enable the effective use of both Engineering data and Product Support data to maximize both the design and the product support infrastructure and its resources.
- Governance via the use of the Sustainment Quad Chart provides insight into RAM metrics, O&S Costs, the Product Support Strategy and Programmatic/Schedule Issues.

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"An Ounce of Design Interface is Worth a Pound of Supply Chain." © 2011 Patrick M Dallosta CPL